

REMARKS

Claims 1, 3 and 5 are pending. By this Amendment, claims 1 and 5 are amended. No new matter is added by any of these amendments. Reconsideration based on the following remarks is respectfully requested.

**I. Amendment Entry after Final Rejection**

Entry of this amendment is proper under 37 CFR §1.116 because the amendments: a) place the application in condition for allowance (for all the reasons discussed herein); b) do not raise any new issues requiring further search or consideration; c) place the application in better condition for appeal (if necessary); and d) address formal requirements of the Final Rejection and preceding Office Action.

The foregoing amendments do not raise any new issues after Final Rejection. Therefore, entry of the amendments is proper under 37 CFR §1.116 because the amendments place the application in condition for allowance. Accordingly, Applicants respectfully request entry of this Amendment.

**II. Claims 1 & 5 Satisfy the Requirements under 35 U.S.C. §112, second paragraph**

Claims 1 and 5 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite. Claims 1 and 5 have been amended to obviate this rejection. Withdrawal of the rejection under 35 U.S.C. §112 is respectfully requested.

**III. Claims 1, 3 and 5 Define Patentable Subject Matter**

The Final Office Action rejects claims 1, 3 and 5 under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent 6,284,093 to Ke *et al.* (Ke) in view of *Silicon Processing for the VLSI Era*, v. 1 (pp. 8, 23-27, 32-33, 59, ©1986) by Wolf *et al.* (Wolf), and further in view of U.S. Patent 6,299,982 to Tamatsuka *et al.* (Tamatsuka). This rejection is respectfully traversed.

Applicants assert that Ke, Wolf and Tamatsuka, alone or in combination, do not teach or suggest a silicon focus ring comprising silicon single crystal used as a focus ring in a plasma apparatus, wherein, in order to produce an intrinsic heavy metal gettering effect of the focus ring, a concentration of interstitial oxygen contained in the silicon focus ring is not less than  $5 \times 10^{17}$  atoms/cm<sup>3</sup> and not more than  $1.5 \times 10^{18}$  atoms/cm<sup>3</sup>, and a nitrogen concentration in the silicon focus ring is not less than  $5 \times 10^{13}$  number/cm<sup>3</sup> and not more than  $5 \times 10^{15}$  number/cm<sup>3</sup>, the intrinsic gettering effect exceeding a corresponding effect for silicon not doped with interstitial oxygen and nitrogen, as recited in claim 1. Applicants further assert that Ke, Wolf and Tamatsuka fail to teach or suggest a method for producing the same from Czochralski grown single crystal silicon, as similarly recited in claim 5.

As recited above, the features of Applicants' claims provides a silicon focus ring doped with nitrogen so that a concentration of interstitial oxygen is not less than  $5 \times 10^{17}$  atoms/cm<sup>3</sup> and not more than  $1.5 \times 10^{18}$  atoms/cm<sup>3</sup>, and a nitrogen concentration is not less than  $5 \times 10^{13}$  number/cm<sup>3</sup> and not more than  $5 \times 10^{15}$  number/cm<sup>3</sup>. Accordingly, Applicants' claims produce the effect that sufficient gettering effect can be afforded to a silicon focus ring, with disadvantages due to impurities such as heavy metal can be prevented, and thereby the yield in fabrication of a semiconductor device can be improved. See page 6, line 21 to page 7, line 3 of the specification.

In rejecting Applicants' claims, the Final Office Action asserts that (a) Ke describes a silicon focus ring, (b) Wolf teaches that the strength of a silicon wafer is increased by oxygen doping and nitrogen doping, (c) Tamatsuka describes the oxygen and nitrogen concentrations recited in the claims. The Final Office Action asserts that therefore, it would have been obvious to one of ordinary skill in the art to form a monocrystalline silicon focus ring of Ke by doping oxygen and nitrogen to increase its strength as taught in Wolf using nitrogen and oxygen concentrations of Tamatsuka, and which are well known in the art. See page 3, line 6

from the bottom to page 4, line 5 of the Final Office Action. The Final Office Action also asserts that the rejection is based on a combination of these applied references, and is set forth with motivation for that combination. See page 5, lines 5-6 of the Final Office Action.

However, even if one of ordinary skill in the art acquires the idea that a focus ring doped with oxygen and nitrogen to improve the mechanical strength of a silicon focus ring, it is impossible that Tamatsuka is combined with this idea so that its oxygen and nitrogen concentrations conform to the values recited in Applicants' claims.

The oxygen and nitrogen concentrations of Tamatsuka are utilized for a wafer for fabrication of a device such as a semiconductor integrated circuit on its surface to suppress crystal defects introduced in the crystal during its growth. See col. 1, line 3 from the bottom to col. 2, line 2 of Tamatsuka. As to a wafer for fabrication of a device, even if a fine crystal defect of 0.1  $\mu\text{m}$  exists on the surface layer portion of the wafer, pattern failure occurs and it affects quality characteristics of the device. Thus, it becomes necessary to suppress crystal defects by controlling its oxygen and nitrogen concentration. See col. 1, lines 16-27, col. 2, lines 39-43 and lines 47-50 of Tamatsuka. Such oxygen and nitrogen concentrations of Tamatsuka do not relate to the object of Wolf to improve the strength of the wafer, and do not relate to the object of Applicants' claims to reduce heavy metal impurities by improving gettering ability.

Moreover, in order to set such oxygen and nitrogen concentrations, it is necessary to control its rotation number of the crucible and atmosphere. See col. 5, lines 17-28 and 53-60 of Tamatsuka. Thus one of ordinary skill in the art would not apply the above conditions to the production of a silicon focus ring that a device is not fabricated on its surface layer portion and which does not relate to elimination of crystal defects.

Therefore, there is no motivation to combine Ke and Wolf with the oxygen and nitrogen concentrations of Tamatsuka. The object of Tamatsuka does not relate to improving

mechanical strength, which corresponds to the advantage cited in Wolf for oxygen being introduced. The oxygen and nitrogen concentrations taught in Tamatsuka entail complicated processes to control doping, and hence would not be routinely embarked on absent adequate motivation. Further, none of the applied references provides any suggestion of improved gettering effect. Thus, combining these references would not only fail to provide Applicants' claimed features, but without addressing the effect of gettering, there is no expectation of success by combining the teachings of Ke, Wolf and Tamatsuka. Accordingly, even if one of ordinary skill in the art combines Ke with Wolf to improve the strength of a silicon focus ring, such a person cannot combine Wolf with Tamatsuka to conform to the oxygen and nitrogen concentrations of the present invention, particularly with any expectation of success regarding gettering effect absent Applicants' disclosure, or for other purposes.

Ke inherently relates to a focus ring. However, Wolf and Tamatsuka relate to a silicon wafer for fabrication of a device. In other words, these inventions have little in common except for the basic material, namely silicon. Therefore, the combination in itself of these applied references is unreasonable. The Final Office Action asserts that a focus ring can be made by boring a hole in a wafer provided by Tamatsuka. See page 4, lines 13-15 of the Final Office Action. Applicants respectfully disagree. A wafer for fabrication of a device is completely different from a focus ring. Because a focus ring is placed on a peripheral portion of the wafer to be etched, its size is much larger than a common wafer. See Fig. 2 of Applicants' disclosure, as compared to fig. 2 of Ke. Accordingly, the focus ring cannot be made by boring a hole in a usual wafer for fabrication of a device.

Further, because a wafer for fabrication of a device is used for fabricating a device on its surface, the requirements to be satisfied include no crystal defects, designated resistivity, specific impurity concentrations, and electric characteristics such as oxide dielectric breakdown voltage characteristics. On the contrary, because a focus ring is placed on a

peripheral portion of the wafer so as to maintain a uniformity of plasma, the focus ring must excel in chemical stability so that the silicon wafer is not contaminated by metal impurities.

See page 2, lines 8-18 of the Applicants' specification. In short, each component is composed of silicon, but their purposes and functions are different from each other.

Therefore, it is impossible for one of ordinary skill in the art to apply the oxygen and nitrogen concentrations in terms of a wafer for fabrication of a device to the silicon focus ring, which is completely different from the wafer for fabrication of a device.

On the contrary rather, in Applicants' claims, because the oxygen and nitrogen concentrations of the focus ring fall within the above-identified ranges, heavy metal contamination on a surface of the focus ring can be prevented. Namely, because a concentration of interstitial oxygen contained in the silicon focus ring is not less than  $5 \times 10^{17}$  atoms/cm<sup>3</sup> and not more than  $1.5 \times 10^{18}$  atoms/cm<sup>3</sup>, and a nitrogen concentration in the silicon focus ring is not less than  $5 \times 10^{13}$  number/cm<sup>3</sup> and not more than  $5 \times 10^{15}$  number/cm<sup>3</sup>, extremely high gettering effect can be obtained. See page 8, line 20 to page 9, line 4 and page 9, line 14 to page 10, line 9 of Applicants' specification. And in practice, in the case that a silicon wafer with a silicon focus ring having oxygen and nitrogen concentrations of Applicants' claimed features was subjected to etching by a plasma etching apparatus, the result that there is little contamination on the above etched wafer as compared to the wafer with a focus ring having different oxygen and nitrogen concentrations from the Applicants' claims was obtained. See page 16, line 1 to page 17, line 5 and Table 1 of Examples 3 and 4.

As described above, in the case of a silicon focus ring having oxygen and nitrogen concentrations of Applicants' claims, the distinctive effect can be obtained, which is not described in the applied references, and as aforementioned, there is no motivation to apply the oxygen and nitrogen concentrations of Tamatsuka to a silicon focus ring, Applicants' claimed features cannot be derived from the combination of the applied references.

And as aforementioned, with oxygen and nitrogen concentrations falling within the range described in the present claims, implementation of Applicants' claimed features can realize an effect which cannot be expected from the applied references. See page 6, line 21 to page 7, line 3 and Table 1 of Examples 3 and 4 of Applicants' specification.

Additionally, the applied references do not describe a focus ring having an oxygen or nitrogen concentration as recited in Applicants' claimed features. Nevertheless, the claims are rejected by the combination of a document which relates to a focus ring, and documents which do not relate to focus rings, and thus lack motivation to combine their reference teachings to achieve the features recited in Applicants' claims. Therefore, Applicants submit that the Final Office Action fails to establish sufficient motivation or a *prima facie* case of obviousness, and therefore the claim rejection under 35 U.S.C. §103 is unreasonable.

Accordingly, independent claims 1 and 5 cannot be properly rejected under 35 U.S.C. §103 over Ke in view of Wolf and Tamatsuka, and hence should be allowed. Further, these arguments also apply to claim 3 that depends from claim 1, and so the dependent claim should be allowed for the same reasons above.

For at least these reasons, Applicants respectfully assert that the independent claims are now patentable over the applied references. The dependent claim is likewise patentable over the applied references for at least the reasons discussed as well as for the additional features it recites. Consequently, all the claims are in condition for allowance. Thus, Applicants respectfully request that the rejection under 35 U.S.C. §103 be withdrawn.

#### **IV. Conclusion**

In view of the foregoing amendments and remarks, Applicants respectfully submit that this application is in condition for allowance. Favorable consideration and prompt allowance are earnestly solicited.

Should the Examiner believe that anything further is desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned representative at the telephone number listed below.

Respectfully submitted,



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